Designing the Conceptual Framework for Automotive Aftermarket

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Abstract

This study's goal is to look into how the rise of electric vehicles in the 4W class is affecting the automotive aftermarket. Aftermarket services refer to an automobile's maintenance; it includes all related activities after its initial purchase and can be described as a secondary market to the automotive sector (Gebaurer et al., 2010). Automobile aftermarket stakeholders include three major groups: consumers, dealers and manufacturers. The adoption of electric vehicles (EVs) signifies a notable transformation within the automotive sector, leading to a decrease in maintenance and spare parts necessities. Although this change might present difficulties for conventional auto repair industries, it ultimately brings advantages for customers in terms of reduced operational expenses, decreased environmental harm, and alignment with the sustainability objectives of electric mobility.

Considering the massive potential of Electric Vehicles and its impact on automotive aftermarket, this article includes a study on particular independent variables that affect the global automobile aftermarket's effective adoption. Findings help automotive aftermarket stakeholders, Electric vehicles and policymakers in understanding how to formulate strategy to mitigate challenges, why and how, can support and enhance customer engagement, scale profits in Electric vehicles repair parts by allocating skilled resources and robust implementation

Interestingly, our findings suggest that flexibility in govt polices and grants in promoting Electric Vehicles and the close proximity of Infrastructure of recharging stations for EV's will pave out the road to successful adoption in automotive aftermarket industry.

Keywords:

Spare Parts, Battery Durability, Infrastructure of Recharging stations, E Mobility Technologies and Govt Polices

1.Introduction

Automotive Aftermarket's growing demands globally remain predominant before the pandemic era and during the pandemic phase. Its demands have always remained steady and is been always attracted consumers due to the unprecedented usage of old vehicle spares. In 2024, the worldwide automotive aftermarket market was estimated to be worth USD 468.91 billion. By 2030, it is expected to reach USD 589.01 billion. The market is anticipated to expand

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between 2025 and 2030 at a compound annual growth rate (CAGR) of 3.8%. This paper aims to identify and assist the automobile aftermarket's stakeholders to prepare them to mitigate the challenges they will face while migrating from IC engines to electric mobility and formulate a strategy that will bring new services/business opportunities to them.

1.1Automotive Aftermarket

Automobile aftermarket stakeholders include three major groups: consumers, dealers and manufacturers. As a rule, manufacturers/producers are businesses that manufacture vehicles and spare parts for their vehicles. Service dealers sell spare parts and perform repairs on vehicles.

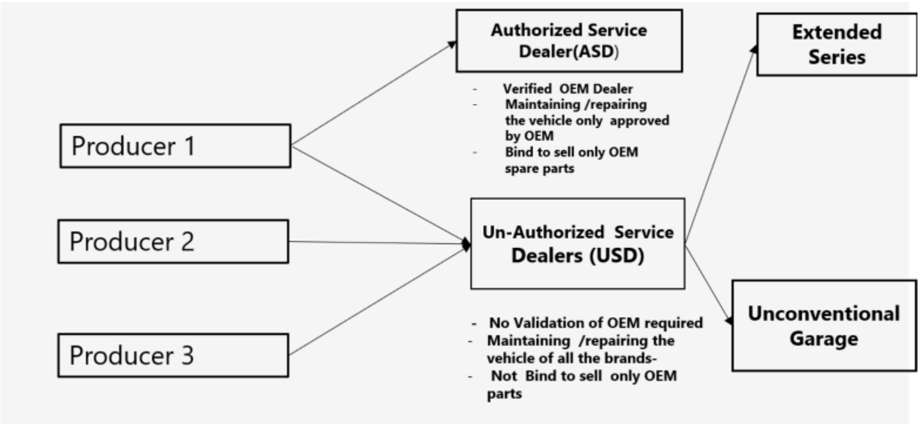

Fig. 1 Stakeholder Associations

1.2 Electric Vehicles in Automotive Aftermarket

A car that is electric (EV) is one that is, either partially or entirely, powered by electricity. Due to their limited number of moving parts, EVs have low maintenance costs and are extremely eco-friendly, since they use only small amounts of fossil fuels (petrol or diesel).

The global revenue for electric vehicles in the four-wheeler segment is projected to reach substantial growth. The market is anticipated to develop at a compound annual growth rate (CAGR) of around 23% from 2022 to reach approximately USD 1.105 trillion by 2030.Specifically, the global electric vehicle market is projected to grow from USD 396.49 billion in 2024 to USD 620.33 billion by 2030 at a CAGR of 7.7%

A core challenge for the automotive aftermarket sector is that maintaining and repairing an EV is significantly easier than an ICE vehicle, as shown in Figure 2. Conversely, a hybrid vehicle requires more effort to operate.

	ICE	Hybrid	REEV	BEV
Oil change	✓	✓	✓	-
Exchange coolant	✓	✓	✓	-
Exchange spark plug	✓	✓	✓	-
Exchange fuel filter	✓	✓	✓	-
Exchange brake fluid	✓	✓	✓	✓
Check power electronics	-	✓	✓	✓
Additional coolant	-	✓	✓	✓
Brake system	✓	reduced	reduced	reduced
Exhaust system	✓	reduced	reduced	reduced
Clutch	✓	reduced	-	-

Fig. 2: Repair and Maintenance of Various Drive Concepts: Data Source: Maintenance of [1]ICE VS Electric

1.3 Research Problem

Given the massive growing population of Electric Vehicles globally, the influence of electric vehicles in the 4w car section of the automotive aftermarket has enormous potential. This calls for a study of the several factors that encourage and hinder the use of electric vehicles in the 4w car automotive aftermarket category. The study aims to investigate the reasons behind the global reluctance of electric vehicles to adopt automotive aftermarket.

1.4 Significance of the Research

It is clear that the automotive market is changing. Engines with internal combustion dominated the market for many years. Cars with alternative drive trains have gained market share recently, and this development has affected the remanufacturing industry for automotive parts. As the number and share of electric vehicles increase, this study aims to describe and evaluate the challenges and opportunities for the remanufacturing industry in the coming years

1.5 Research Questions

The automotive aftermarket is a high-potential market for every manufacturer and always reaps high profitability year after year. Understanding the impact electric vehicles will have on the automotive aftermarket and the entire stakeholders i.e. Automotive Manufacturers, Distributors, Dealers, and Technicians very crucial.

The objective of the research is to establish the factors impacting electric vehicles on the automotive aftermarket:

1. How will electric vehicles bring new services/ business opportunities for entire aftermarket automotive stakeholders (i.e. Automotive Manufacturers, Distributors, Dealers, and Technicians)?
2. What challenges the entire aftermarket automotive stakeholders(i.e. Automotive Manufacturers, Distributors, Dealers, and Technicians) will face while migrating on the business front from IC engines to Electric Vehicles?
3. Does the small Dealers/workshop will survive due to this disruption created by electric vehicles?
4. What strategy (Customer tie up, Profit Potential, Resource Intensity, Implementation Process) should the aftermarket automotive stakeholders (i.e. Automotive Manufacturers, Distributors, Dealers, and Technicians) adopt to sustain itself in this market?

5. How Govt policies will play role in shaping up in promoting electric vehicles?
6. How Battery Electric Vehicles will create a space in market?

1.6 Research Objectives

1.To understand the implication of Spare parts count with respect to ICE & Electric vehicles for the aftermarket automotive stakeholders (i.e. Automotive Manufacturers, Distributors, Dealers, and Technicians)
2.To establish the role of Battery Durability/ Life for the for the aftermarket automotive stakeholders (i.e. Automotive Manufacturers, Distributors, Dealers, and Technicians)
3.To understand the role of Different e mobility technologies/ Telematics in the electric vehicles
4.To understand the role of Battery Recharging stations/ Infrastructure which can be key lever in establishing a range of electric vehicles
5.To understand the major role played by the Governments to promote the electric vehicle
6.To establish the role of Battery Electric Vehicles will cater to the market

1.7 Research framework

In order to illustrate possible interrelationships between independent variables and dependent variables, a graphical representation was devised. A determinant of the impact of electric vehicles on the automotive aftermarket is included as an independent variable. The independent variables as demonstrated below are: Spare Parts, Battery durability, E mobility Technologies, Infrastructure of recharging stations, Govt policies and demand for Battery electric Vehicles.

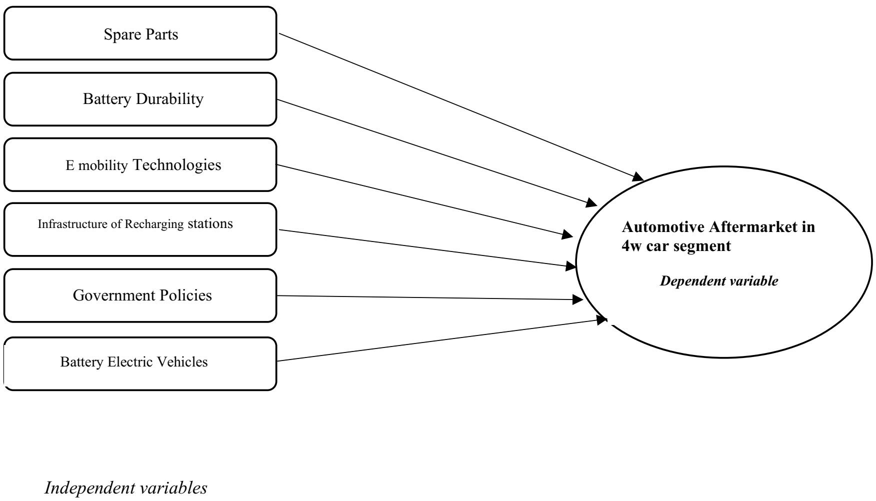

Figure 3: Research framework

2.0 **Literature Review**

Electric Vehicles have been the subject of several studies in the automotive aftermarket. A secondary data source was used to gather existing knowledge on this topic within the scope of the current study. As part of this review, leading international electronic databases such as EBSCOhost, ProQuest Central, Education Research Complete, Education Resources Information Center (ERIC), DeepDyve, Routledge, Taylor & Francis Online, ISI Thomson, and Google Scholar were used to search for literature.

An analysis of existing research gaps (limitations) and research findings was conducted to position this research. Finding new facts and contributing to the body of knowledge are vitally important when there are gaps in research. A spreadsheet was formulated with over 300 articles and seven variables (six independent variables and one dependent variable). To add value to the research analysis and findings, each article is summarized and analysed in figure 4 which is Seetha patented format.

THE IMPACT OF ELECTRIC VEHICLES ON AUTOMOTIVE AFTERMARKET"

Authors (Year), Topic of the Article, Name of the Journal. Vol. No. Issue No.	Major findings	Variables	Research Model/Tool /Theory	Limitations or Scope for further research
Impact of Electric Mobility on the After Sales Service in the Automotive Industry Uwe Dombrowskia , Christian Engela *	1.This chapter contains the description of the development of a method which allows the after sales service stakeholders to assess and adjust their existing after sales service strategies. 2. The method development was carried out in three sequenced steps. a) **Market Assesment** :. As a tool for this step the scenario technique wasapplied. This technique is a very structured methodology which delivers a high quality of results. b) **Identification of Strategies**:This strategy includes the leasing of the entire car or solely the leasing of the battery. The lessor finances the car respectively the battery while leaving the use of the car to the lessee by a contractually agreed leasing rate.The aim is to attract a wider customer base in addition to the sale of automobiles.Due to the contractual obligations of the lessee, this method is particularly suitable for customer loyalty .The following factors are particularly important for the evaluation of the impact of a strategy: xCustomer tie xResource intensity x Profit potential	**Dependent: Automotive Aftermarket** **Independent:** Electric vehicles ,Leasing of car / batteries, new business models, Customer tie, Resource intensity,Profit potential & Implementation process	Strategy Identity Card	1. The highly profitable automotive aftermarket is threatened by the rising share of electric cars due to many reasons. [**7**], [**12**] In this paper, therefore a method for the selection of possible strategies for the after sales service market in the automotive industry is presented. 2.Using this method appropriate it is possible to select strategies in a simple way. 3.The additional benefit of this method is the consideration of the future market development by regarding the relevant key indicators of the automotive aftermarket. 4.Stakeholders are enabled to facilitate and improve their specific market position by using this method and by implement the right after sales strategies. 5.The methodology is deliberately developed in a very simple way to ensure a comfortable handling, in particular to small and medium-sized stakeholders in the automotive after sales service. 6.As further research a more detailed method is needed. The market indicators have to be clarified more precisely. Several levels (layer) will be included which allows a more sophisticated selection of strategies . 7Finally, the method should be adjusted to all affected stakeholders in the automotive aftermarket in order to improve their position by using the presented method

Fig 4. A snapshot exemplifying the summary of 300 articles.

2.1Factors influencing the impact on Automotive aftermarket in 4wheeler car due to influx of Electric Vehicles

. Research conducted by Aitken and He (2018) underscores that electric vehicles eliminate the necessity for intricate engine elements like exhaust systems and conventional transmissions which leads usage of fewer spare parts compare to ICE vehicles

2.1.1Spare Parts (SP)

The continuous and reliable operation of machinery and equipment heavily relies on the presence of spare parts. In their study, Achanga et al. (2006) emphasize the importance of spare parts in raising an organization's total equipment effectiveness and operational efficiency. Spare parts serve as a safety net against unplanned malfunctions and are essential for planned maintenance and repairs, hence reducing costly downtime (Chan et al., 2001). Adopting sustainable practices, including part recycling and reuse, is essential to reducing this environmental load (Yusof et al., 2018).

2.1.1.1 ICE Spares Parts

. In a wide range of industries, including power generating, automotive, and aviation, internal combustion engines, or ICEs, are widely used. Because sustainability is becoming more and more important, sustainable practices are becoming more and more important in the engine and automobile production industries. It is impossible to ignore the effects of spare parts production, disposal, and recycling on the environment. To lessen this ecological imprint, eco-friendly material adoption, appropriate disposal, and effective recycling procedures are therefore essential (Teixeira et al., 2021).

2.1.1.2 Electric Vehicle Spare parts

According to Aitken and He (2018), spare components greatly minimize EV dependability and downtime. Sustainability is playing a bigger role in the automotive sector.. These include recycling and using eco-friendly materials (Zhou et al., 2020).Fewer Spare Parts for Electric Vehicles: As a result of the widespread use of electric vehicles (EVs), there is a noticeable reduction in the requirement for spare parts for vehicle upkeep and repair.

There are several important variables that contributed to this decrease. Due to their intrinsic simplicity, EV systems are more reliable, which lowers the likelihood of malfunctions and the need for replacement parts (Liu, Peng, & Huang, 2019).

The following hypotheses were formulated:

H1. Spares Parts significantly influences on automotive aftermarket in the Electric Vehicles 4W segment

2.1.1.2 Battery Durability (BD)

In the context of electric mobility, battery durability is a critical component of electric vehicles (EVs) because it directly affects the vehicle's performance, range, and affordability.This article explores the topic of EV battery durability, focusing on the important variables that influence battery lifespan and methods to extend it. Elements that affect how long a battery lasts. The choice of electrode materials, electrolytes, and cell designs is crucial to extending battery lifespans (Scrosati et al., 2011).Operating Conditions: Deep discharges, high charging and discharging rates, and extremely high temperatures can all hasten battery deterioration (Arora & Zhang, 2004).In order to allay consumer concerns about battery deterioration and replacement costs, manufacturers offer longer warranties and battery replacement programs, which helps to increase consumer confidence in BEVs (Nykvist et al., 2015).

2.1.1.4 Life cycle of Battery

The ecology is significantly impacted by the production of lithium-ion batteries. Lithium, cobalt, nickel, and graphite are among the raw minerals that are mined, refined, and processed to make these batteries. The energy consumption and greenhouse gas emissions from these processes are substantial (Dunn et al., 2015).

2.1.1.5 Battery Attributes

Electric Vehicles (EVs) play a crucial role in pushing the change towards sustainable transportation. A key element in guaranteeing the success of these vehicles are the batteries that power them. The current literature study explores the key features of EV batteries and evaluates their significant influence on the vehicles' overall sustainability, performance, and range.

The following hypotheses were formulated:

H2: Battery Durability significantly influences on Automotive Aftermarket in Electric Vehicles 4-wheeler Car segment

2.1.3 E Mobility Technologies (EMT)

The use of electric vehicles is crucial to the goal of a sustainable and environmentally friendly future. As the forerunners in this change, electric vehicles (EVs) are essential. However, e-mobility technologies must be continuously improved to optimize their effectiveness, usability, and environmental advantages. This thorough analysis explores the key e-mobility technologies used in EVs and their significant impact on transportation in the future.

According to Dunn et al. (2015), regenerative braking is crucial for extending battery life in addition to optimizing energy use. Increases in these components' efficiency lead to better power conversion, lower energy losses, and eventually a greater vehicle's overall efficiency (Rathore et al., 2017).

2.1.3.1 Software Components

In addition to advancements in hardware components, software innovations have played a crucial role in the amazing growth of electric vehicles (EVs). This thorough analysis explores

the crucial software elements that enable EV e-mobility technologies, highlighting their importance in boosting vehicle performance, guaranteeing safety, and improving user experience. Enhancing charging and discharging cycles, protecting against possible overcharging, and finally ensuring the highest level of battery safety and longevity are their main goals (Deng et al., 2013).

Electric vehicle (EV) control software is crucial for improving efficiency and performance. The program dynamically adjusts power supply based on driving circumstances and driver inputs by utilizing advanced motor control algorithms. This leads to improved energy efficiency, smoother acceleration, and effective regenerative braking (Gao et al., 2019).To maximize the vehicle's remaining range, these algorithms take into account a number of variables, including weather, traffic, and the complexity of the terrain (Nehme et al., 2016).

The efficiency, convenience, and security of electric vehicles (BEVs) are all improved by the ongoing advancements in e-mobility software technology. Software developments are crucial in determining the future of sustainable transportation as the e-mobility sector continues to develop.

2.1.3.2 Hardware Components

Significant technological advancements have recently been made in electric vehicles (EVs), particularly in key hardware components that improve EVs' efficiency, performance, and range. The basic hardware elements that underpin EV e-mobility technologies are examined in this study of the literature, with an emphasis on their significant role in shaping the future of environmentally friendly transportation. The essential part of electric vehicles (EVs) are electric motors, which play a key role in converting electrical energy from the battery into mechanical energy for forward motion. The use of high-efficiency and high-torque motors is essential for EVs to achieve peak performance and rapid acceleration (Gao et al., 2019).

2.1.3.3 Management of the Software & Hardware Services

In the field of e-mobility technologies, the effectiveness of electric vehicles (EVs) is largely dependent on the effective management of hardware and software services. In order to improve vehicle performance, customer pleasure, and ecological sustainability, this literature review explores the management aspects of software and hardware services in EVs. For batteries in electric vehicles (EVs) to operate safely and optimally, the battery management system (BMS) must be properly managed. The BMS software ensures fair charging and draining while continuously monitoring the battery's temperature, condition, and charge level. By avoiding circumstances of excessive charging or discharging, this eventually extends the battery's life (Deng et al., 2013).An important factor in the uptake of electric vehicles (EVs) is the management of charging infrastructure. This includes the meticulous design and maintenance of both home charging options and fast-charging stations. Convenience is increased and the viability of EVs is reinforced by the effective administration of this network (Zhang et al., 2018).

Software and hardware management must work together harmoniously for electric vehicles (EVs) to operate at peak efficiency and lifetime. For instance, the seamless integration of battery and thermal management plays a crucial role in maintaining the battery at ideal temperatures, thereby elongating its operational lifespan and upholding peak efficiency (Pesaran et al., 2015).

The following hypothesis was generated:

H3: E mobility Technologies significantly influences on Automotive Aftermarket in Electric Vehicles 4W segment

2.1.4 Infrastructure of Recharging stations (IRS)

Consumers, one of the critical decisions in buying electric vehicles will be recharging stations hence if all the Dealer networks/workshops, if they have a recharge station, will have an extra benefit for the Dealers to have an additional business opportunity along with any servicing required for electric vehicles.

a) UK electric car charging points: The UK's public EV charging stations are marked on this map of all their locations. Over 42,000 chargers can now be found across the UK, at over 15,500 locations - that's more public chargers than petrol stations.

Thousands of free electric car charge points are located in the UK, often in supermarkets, shopping centers, public parking lots, hotels, and service stations. Consider that there may be restrictions, such as a set time period or a requirement to make a purchase in-store, so be aware.

b) Indian Charging stations (E Amrit) Govt of India:

Availability of recharge stations in south Asia, society, difficulty, etc. The availability of charging stations in India is not densely populated hence its difficult for consumers to arrive at a purchasing decision for Electric Cars.

2.1.4.1 Number of Electric Recharging stations

In recent years, the utilization of Electric Vehicles (EVs) has witnessed a significant increase, primarily driven by environmental and economic concerns . EVs offer numerous advantages over traditional gasoline vehicles (GVs), including minimal or zero emissions and enhanced energy efficiency, making them an excellent choice for transportation in urban areas . According to the estimations made by Lee and Han [2006], the sales of EVs are expected to grow at an annual rate of over 25% by 2025. The rising popularity of EVs can be attributed not only to their environmental friendliness but also to the various incentives provided by governments, such as purchase incentives, free parking facilities, and reduced access restrictions.

2.1.4.2 Distance between the Recharging stations

Two methods are frequently used in the field of electric vehicle (EV) deployment: flow-based methods and spatial methods. In order to guarantee that drivers can conveniently recharge their batteries before they run out of juice, spatial techniques usually entail reducing the distance between recharging stations and the EV drivers they serve. One example of a geographic strategy is the p-median technique, which seeks to decrease the number of stations while maximizing coverage. Since it is impractical to get full coverage throughout a region, this method is especially useful for resolving urban transport planning issues.

Therefore, even while each strategy has advantages, it is crucial to take into account the unique objectives and constraints of each when choosing the best way to install charging stations for electric cars.

2.1.4.3 Types of Chargers

Developing a charging infrastructure that accommodates various charger types is essential to the transition to Electric Vehicles (EVs). As we examine the nuances of these charger types, we consider technology advancements, user preferences, infrastructure deployment, policies,

consider policies , challenges and future developments. The technology advancements, user preferences, infrastructure deployment, policies, challenges, and future developments.

Types of Chargers: Chargers :Residential charging relies on AC chargers, which provide standardized and accessible solutions (Smith & Johnson, 2018; Brown, 2019).

Direct Current (DC) Chargers: The DC charger plays an essential role in public charging networks because of its rapid charging ability and long-distance travel capabilities (Jones et al., 2020; Patel & Gupta, 2019).

Wireless Charging :The advent of wireless charging technologies, which eliminate physical connections, offers convenience and the possibility of advancing charging infrastructure (Wang & Kim, 2021; Garcia et al., 2018).

Technological Advancements : Level 1 Charging: Residential charging is compatible and essential with Level 1 charging, which utilizes standard household outlets (Miller et al., 2017; Anderson, 2020).This chapter centres on the critical discoveries outlined in the literature review regarding various charger types for Electric Vehicles (EVs). It highlights the intricate characteristics of these chargers, ultimately leading to the conclusion that a well-rounded and all-encompassing approach is imperative for policy development and infrastructure planning.

2.2.4.4 Infrastructure facilities

The public charging infrastructure is located on publicly owned property and is easily accessible to the general population. In this context, we describe a charging point as "publicly accessible" if it is located either on a public street or on private land that can be accessed and used by any unidentified group of individuals (BMWi, 2015).

Three different kinds of public charging infrastructure intended for light-duty vehicles are the subject of our investigation. As an alternative to private charging, these include: (1) charging stations close to residential areas; (2) opportunity charging while parking at points of interest (POI charging), like supermarkets; and (3) fast charging stations mainly located along high-power travel corridors to enable long-distance travel (DC high power charging).

Since the US, Europe, China, and Japan account for more than 97% of the worldwide PEV market, our analysis primarily focuses on these markets (IEA, 2018). As representatives of major auto markets, we focus on Norway, the largest PEV market in Europe, as well as France, Sweden, the United Kingdom, the Netherlands, Germany, and Poland.The findings of our study on charging infrastructure availability in 2017 are summarized in fig 5 and Fig 6

Fig 5 Charging infrastructure availability in 2017 . Data Source IEA (2018),EAFO (2017), Eurostat(2017), AFDC(2017); R&M (2019)

Status quo (year 2017) of charging infrastructure availability. Data sources: IEA (2018); EAFO (2017); Eurostat (2017); AFDC (2017); R&M (2019). CP = charging point.

Parameter	China	US	France	Germany	Japan	Netherlands	Norway	Poland	Sweden	UK	World
PEV per charge point	6	17	7	5	7	4	19	4	12	10	7
BEV per DC fast charge point	11	64	59	28	14	46	94	6	20	22	17
ICEV per gasoline station	2200	1600	2900	3000	1900	2000	1400	2900	1500	3400	n/a
CP (DC + AC) per gasoline station	1.94	0.27	1.43	1.68	0.72	8.03	5.24	0.06	1.37	5.45	n/a

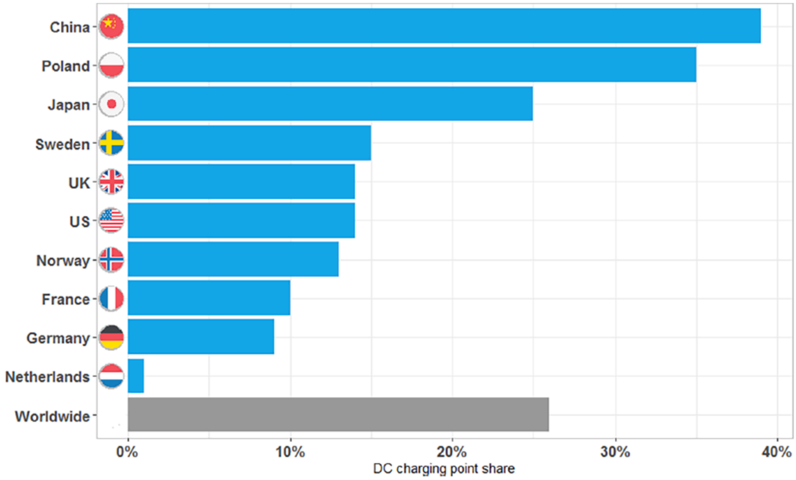

Fig 6 Charging infrastructure availability in 2017 . Data Source IEA (2018),EAFO (2017), Eurostat(2017), AFDC(2017); R&M (2019)

Two viewpoints can be obtained regarding the requirements of charging infrastructure for various nations.

The following hypotheses were formulated:

H4: Infrastructure of Recharging Stations significantly influences the Automotive aftermarket in Electric Vehicles 4 wheeler segment

2.1.5 Govt Policies

Government policies related to the adoption of Electric Vehicles (BEVs) differ across countries and are primarily aimed at promoting the use of electric vehicles for environmental preservation, economic growth, and energy independence. Presented below are several typical categories of government policies associated with the adoption of EVs:

Incentives & Subsidies:"The global outlook on policy instruments for advancing electric mobility is examined in the article titled 'Policy instruments to promote electric mobility: A global perspective', authored by Axsen et al. (2017) and published in Transport Policy. Thiscomprehensive study delves into a range of incentives and subsidies as effective measures in encouraging the adoption of electric vehicles worldwide."

To promote the use of battery electric vehicles (BEVs), several governments provide financial incentives. These incentives encompass tax credits, rebates, or direct subsidies to facilitate the purchase of electric vehicles. These initiatives effectively lower the initial expenses associated with EVs, thus enhancing their appeal among consumers.

2.1.5.1 Net Zero Carbon 2050

By the year 2050, "Net Zero Carbon" is a global target aimed at balancing emissions of greenhouse gases with emissions of greenhouse gases that are offset or removed from the atmosphere. In other words, atmospheric carbon dioxide (CO2) levels should not increase nettily. International climate agreements, such as the Paris Agreement, outlined limiting global warming to well below 2 degrees Celsius above pre-industrial levels as a key priority for dealing with climate change. The following are key aspects of the goal of achieving Net Zero Carbon by 2050 Climate change and the transition to a low-carbon, sustainable future are urgent challenges that must be addressed. The Net Zero Carbon 2050 target reflects this global consensus. In order to succeed, governments, businesses, communities, and individuals must collaborate.

2.1.5.2 UK Govt Grants

Based on my last knowledge update in January 2022, the UK government has implemented a range of grants and incentives aiming to encourage the adoption of Battery Electric Vehicles (BEVs) and facilitate the growth of charging infrastructure. However, it is crucial to bear in mind that programs and specifics may have been modified since then. Therefore, it is essential to consult official government websites for the most up-to-date information. Based on my latest update, the following highlights key grants and incentives concerning BEVs in the UK.

2.1.5.3 Indian Govt Grants

Based on my last knowledge update in January 2022, the Indian government has introduced different measures and initiatives to encourage the acceptance of Battery Electric Vehicles (BEVs) and facilitate the growth of eco-friendly transportation. However, it is important to recognize that programs and details may have changed since then. As a result, it is advised to consult relevant authorities for advice or examine the most recent data on official government websites. It is advised to consult the Department of Heavy Industry's (DHI) official website or other relevant government authorities to get the most accurate and up-to-date information about grants and incentives available for EVs in India.

Likewise, it is advisable to consult state-level transportation departments for region-specific programs or incentives. It should be noted that the electric vehicle sector in India is constantly progressing, with the possibility of new policies and incentives being introduced to enhance the promotion of sustainable transportation.

2.1.5.4 Lucrative govt policies for aftermarket

The aftermarket industry can benefit from diverse and advantageous government policies, which may differ from one region to another. These policies aim to foster safety, environmental

sustainability, innovation, and economic growth. Consider the following potential lucrative government initiatives that could greatly impact the aftermarket sector:

The following hypotheses were formulated:

H5: Government Polices significantly influences the Automotive aftermarket in Electric Vehicles 4 wheeler Car segment

2.1.6 Battery Electric Vehicles (BEV)

Battery Electric Vehicles (BEVs) represent a specific category of electric vehicles exclusively driven by an electric battery. In contrast to hybrid vehicles that harmonize an internal combustion engine along with an electric motor, BEVs entirely depend on electric energy for their propulsion. Below are several essential traits and attributes defining Battery Electric Vehicles: The range of battery electric vehicles (BEVs) has been expanding steadily with technological advancements in batteries. The range of a BEV is influenced by several factors including battery capacity, efficiency, and vehicle design.

s technology continues to progress, battery electric vehicles (BEVs) are expected to have a noteworthy impact on the future of transportation. They will form an integral part of endeavours aimed at diminishing reliance on fossil fuels and mitigating environmental consequences.

2.1.6.1 Size of the market

Driving Factors: One of the primary factors that is anticipated to stimulate the demand for electric vehicles in India is the surge in gasoline prices. While fossil fuel-powered vehicles are initially cheaper to purchase compared to electric vehicles (EVs), their operational costs are significantly higher due to the continuously increasing fuel and diesel prices. Conversely, electric cars have considerably lower operating expenses, making them a more economical choice over time. Consequently, the rise in fossil fuel prices and the subsequent shift in consumer preferences towards electric cars are expected to drive market growth throughout the forecast period. This thorough examination enables an assessment of the overall competition within the market. Moreover, consumers gravitate towards store-based channels due to their ability to provide a convenient and all-in-one purchasing experience.

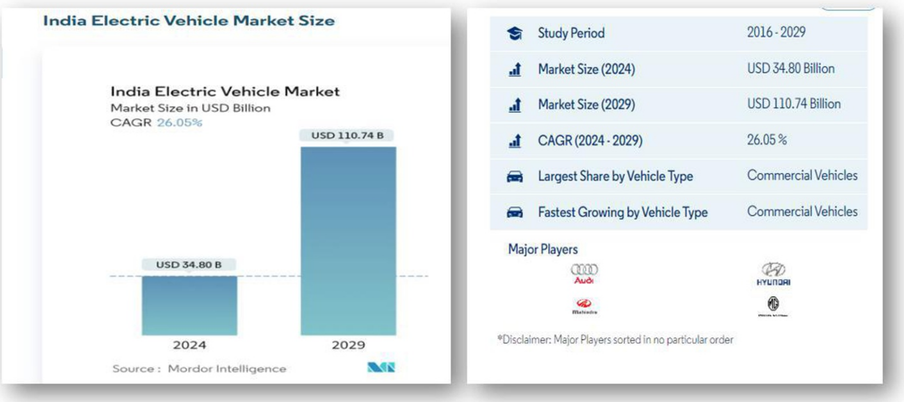

Fig 7 Indian Electric Vehicle Market. Data Source : Mordor Intelligence

When determining the distance a Battery Electric Vehicle (BEV) can cover on a single charge, numerous factors come into play, such as the vehicle's battery capacity, efficiency, driving conditions, and the driver's behaviour. Below are pivotal aspects to take into account:

Battery Capacity is the foremost factor that impacts the range of a BEV. A BEV with a larger battery capacity tends to offer an extended range. The measurement of battery capacity is usually expressed in kilowatt-hours (kWh).

Vehicle Efficiency: The range of an electric vehicle can be influenced by the efficiency of its motor and overall design. Vehicles with superior efficiency have the ability to cover greater distances while utilizing the same amount of energy.

2.1.6.3 Skilled Technicians:

The rapidly expanding electric car market offers a multitude of job opportunities in a variety of industries, including IT firms that specialize in creating software for electric vehicles and charging station companies. As a result, policies that support the many new job prospects in the electric car sector should be put in place by the government. The development of new technologies, the accessibility of charging infrastructure, and governmental regulations are some of the variables that will affect the future of electric mobility jobs, according to Dijk, Orsato, and Kemp (2013).How many well-paying job opportunities does the electric car business generate, and how does it stack up against the conventional automotive industry? Accordingly, the study by Walter, Higgins, Bhattacharyya, Wall, and Cliffton (2020) emphasizes the potential for the U.S. auto manufacturing sector to lead the global transition to electric vehicles, highlighting the potential for job growth in the country.

The need for improved training programs that give technicians the most recent information and abilities in the quickly changing electric car technology was underlined by Fechtner and Schmuelling (2016).Furthermore, in order to handle the complexities of repairing and maintaining electric vehicles, there is an increasing need for thorough hands-on training. Furthermore, Turoń, Kubik, and Chen (2021) noted that the younger generation's lack of knowledge about electric mobility calls for thorough instruction supported by a variety of effective teaching strategies. Additionally, Brusaglino, Gava, Leon, and Porcel (2013) discovered that European competences in the maintenance of electric and hybrid vehicles needed to be developed.

2.1.6.4 Critical components of BEV

Reconfiguration alone does not cancel the constraints of conventional battery systems if any cell’s status is unknown. In practice, it is impossible to use the switches sensibly without this understanding. However, for a variety of reasons, the states of every cell are rarely accessible in typical battery systems. While many essential cell states, such the State of Charge (SOC) or the State of Health (SOH), cannot be directly assessed, a significant number of sensors and cabling efforts would be required. As a result, a lot of work needs to be done to keep an eye on each battery cell's condition. Researchers and studies in a variety of sectors attempt to address the many issues that occur from non-reconfigurable battery systems with unknown states of the individual cells. Two complementary approaches are used in the literature to solve the problem of advanced monitoring. First, algorithms are used for model-based or data-driven fault diagnosis, condition, and parameter estimation. Second, for dependable data collection, the use of highly sophisticated sensors is required.

Potential capabilities are shown, and the required system topologies are examined at both the micro and macro levels, with an emphasis on adaptable configurations to circumvent the limitations of non-reconfigurable multi-cell battery systems.

2.1.6.5 Sales Automation:

Sales automation is essential to meet the increased size of aftermarkets of BEVs. Sales automation in the automotive industry streamlines various sales processes using technology to enhance efficiency and customer experience. This includes automating tasks like lead management, follow-ups, inventory tracking, and marketing campaigns. Automation can lead to faster deal closures, increased sales, and improved customer satisfaction.

2.1.6.6 Accessibility to recharging stations:

Recharging capabilities will be installed at appropriate locations to ensure easy accessibility to meet the increased size of aftermarkets of BEVs. It is well accepted that the construction of a charging infrastructure is crucial for the expansion of battery electric vehicles (BEV).Many governments are creating plans to install experimental networks of slow charging stations in cities to encourage and support the use of these vehicles. Selecting the ideal sites for the stations is crucial for the advancement of electrical mobility since it will encourage the buying of BEVs.

Most of the time, the plans select parking spots at well-known locations, like city centers, malls, train stations, and college campuses. Although these locations are quite visible, the short parking duration and high rotation rates that are frequently seen there may not provide a sufficient solution for the users' actual daily charging needs. In this study, using the concept of personal charging coverage, we suggest a method for charging station placement that considers these requirements.

The following hypotheses were formulated:

H6: Battery Electric Vehicles significantly influences the Automotive Aftermarket in Electric Vehicles 4 wheeler segment

3.2 Research Methodology

The systematic literature review has been conducted on various scholarly articles, white paper, various govt policies. A wide range of scholarly articles were downloaded and further reviewed depending upon the topic on the automotive, aftermarket, electric vehicles, govt polices, Recharging stations, green mobility etc. The scholarly article was further reviewed on the basis of the quality of abstract, introduction, literature, findings and their gap. After thorough review of the scholarly article's independent variables, sub -variables were identified along with the outcomes by using professor Seetha's patented template and methodology as shown in fig no .2.1

The conceptual model for the automotive aftermarket was created by identifying independent variables along with sub variables and possible outcomes by reviewing the scholarly articles.

After deriving from the total no of 6 independent variables and sub variables from the literature review the possible hypothesis was formed. This six-hypothesis originating from the six independent variables impacting the dependent variable on the automotive aftermarket were formed by the review of literature.

3.3 Summary, Discussion, Framework Design & Conclusion

Literature review delves into to the formation of independent variables which are significant to understand the impact which may get created in the automotive aftermarket with the entry of electric vehicles in 4w segment. The independent variables reviewed out of various scholarly articles are as followed -Spares Parts, Battery Durability, E Mobility Technologies, Infrastructure of Recharging stations, Govt policies & Battery Electric Vehicles may be the key parameters for the successful adoption of the model in the automotive aftermarket.

Consequently, the sub variables related to each independent variables are also the why & how factor in which all the six independent variables are deeply rooted to address the impact on the automotive aftermarket. The each sub-variables for every single independent variables carries significant value to the overall paper. This paper identifies following sub variables like – Count of spares parts for ICE & Electric Vehicles which plays an important factor for the independent variables Spare Parts. Similarly other sub-variables like - Life cycle of Battery and Battey Durability also plays a contributing role in the Independent variable Battery Durability. The next set of significant sub variables reflecting in the category of identified independent variables of E mobility Technologies - Software components, Hardware components and management of Software & hardware components are also the key levers in this paper. The other 3 Independent variables like Infrastructure of Recharging Stations, Govt Polices & Demand in Battery Electric Variables which are very critical in nature and may have strong foothold for the impact to be created on the automotive aftermarket are as follows - No of Electric Recharging Stations, Distance between Recharging stations, Types of Charger and infrastructure facilities categorised under Infrastructure of Recharging Stations. The Net Zero Carbon 2050, UK Govt Grants , Indian Govt Grants , Lucrative Govt Polices for aftermarket and Interest Free loan/ land are some of the impactful handful sub-variables segmented under the independent variables Govt Polices may bring impact in the automotive aftermarket with the introduction of Electric Vehicles. The demand for Battery Electric Vehicles in the category of Electric Vehicles and its sub -variables- Skilled Technicians, Critical Components , Sales Automations and Infrastructure facilities may also pave a significance aspect in the impact on the automotive aftermarket.

Based on the thorough literature review mentioned above and an analysis of their important independent and sub-variables, this paper suggest and designs the conceptual model for the automotive aftermarket with the impact of electric vehicles in 4W segment as mentioned in fig 4.2 with possible outcomes which may be further studied by the researchers, automotive & electric vehicles mfg stakeholders, automotive aftermarket stakeholders and policy makers.

The paper also suggest and advise to come at conclusion the richness of possible outcomes which will be benefited to scale business in their individual capacity to all the stakeholders of aftermarket automotive stakeholders globally as it throws light and significance on profit potential complemented by govt policies , skilled technicians and workmanship may be needed globally as the footprints of Electric Vehicles gain mileage globally, consumer preference for Battery Electric Vehicles (4W segment) may surge as the proximity of Infrastructure for Battery Recharging stations is adopted widely ,finally new Business avenues for setting up

Infrastructure for Battery Recharging stations may come up aggressively globally and demand for manufacturing of Battery in EV's may surge high as it may be most important component and it will replace the slowly the major components in ICE Vehicles i.e. Engine.

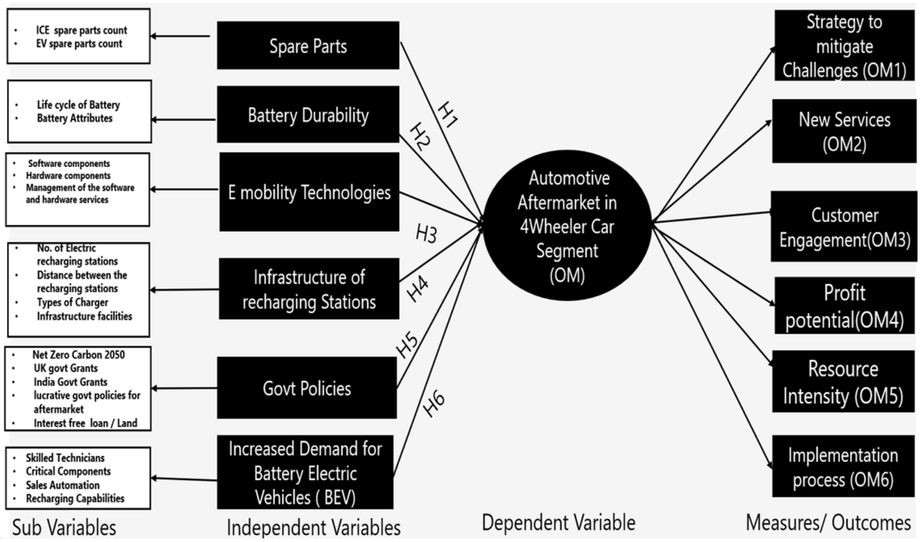

Fig 8. Conceptual framework

3.4 Limitations and Scope for Future Research

The study has some limitations . The study was based on selected limited data base which is only in the language of English. The other set of journals or scholarly articles which are published in other language apart from English is not reviewed further.

The six hypotheses which this paper have come out of the quality of literature review underline below will need to be further tested by data analysis to test the conceptual model:

H1. Spares Parts significantly influences on automotive aftermarket in the Electric Vehicles 4W segment
H2: Battery Durability significantly influences on Automotive Aftermarket in Electric Vehicles 4-wheeler Car segment
H3: E mobility Technologies significantly influences on Automotive Aftermarket in Electric Vehicles 4W segment
H4: Infrastructure of Recharging Stations significantly influences the Automotive aftermarket in Electric Vehicles 4 wheeler segment
H5: Government Polices significantly influences the Automotive aftermarket in Electric Vehicles 4 wheeler Car segment
H6: Battery Electric Vehicles significantly influences the Automotive Aftermarket in Electric Vehicles 4 wheeler segment

By researching academic and professional material on the adoption of electric vehicles in the 4w car segment area of the automotive aftermarket and creating, utilizing, and implementing and evaluating research artefacts in collaboration with scholars, businesspeople and aftermarket stakeholders(Automotive manufacturers, Distributors, Dealers, Technicians, consumers etc.)

Highlights

- After detailed literature review the following 6 factors are identified as important to impact the automotive aftermarket – Spare Parts, Battery Durability, E Mobility Technologies, Infrastructure of Recharging stations, Govt Policies & Demand of Battery Electric Vehicles
- Profit potential for aftermarket stakeholders may increase as the adoption of Electric Vehicles (4W segment) surges complemented by govt policies
- Skilled Technicians and workmanship may be needed globally as the footprints of Electric Vehicles gain mileage globally
- The consumer preference for Battery Electric Vehicles (4W segment) may surge as the proximity of Infrastructure for Battery Recharging stations is adopted widely
- New Business avenues for setting up Infrastructure for Battery Recharging stations may come up aggressively globally

- The Demand for manufacturing of Battery in EV's may surge high as it may be most important component and it will replace the slowly the major components in ICE Vehicles i.e. Engine

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